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Criteria for Municipal Solid Waste Landfills (40 CFR Part 258). Subtitle D of Resource Conservation and Recovery Act (RCRA). Summary of Data on Municipal Solid Waste Landfill Leachate Characteristics

NUS Corp., Rockville, MD

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In August 1988, the U.S. Environmental Protection Agency proposed Solid Waste Disposal Facilities Criteria (40 CFR Part 258) for municipal solid waste landfills. This background document is the basis for the development of a portion of the Subtitle D criteria.

This document presents information on the character of leachate from municipal solid waste landfills based on a study of existing leachate data. The purpose of this document was to: 1) investigate municipal solid waste landfill leachate, 2) determine the constituents present, 3) determine the concentrations of the constituents present relative to human health and environmental regulatory standards, and 4) evaluate the effects of Subtitle C hazardous waste regulations on constituent concentrations in municipal solid waste landfill leachate. This document describes the sources of the data and its quality and presents the results of the study.

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BACKGROUND DOCUMENT

SUMMARY OF DATA ON
MUNICIPAL SOLID WASTE LANDFILL
LEACHATE CHARACTERISTICS

"CRITERIA FOR MUNICIPAL SOLID WASTE LANDFILLS"
(40 CFR PART 258)

SUBTITLE D OF RESOURCE CONSERVATION AND
RECOVERY ACT (RCRA)

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE

JULY 1988

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1.0 INTRODUCTION

The 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) directed EPA to revise the "Criteria for Classification of Solid Waste Disposal Facilities and Practices" (40 CFR Part 257) for facilities that may receive household hazardous waste or hazardous waste from small quantity generators. Such revisions shall be those necessary to protect human health and the environment and may take into account the "practicable capability" of facilities to implement the Criteria (HSWA Section 302). "practicable capability" was included in HSWA by Congress to take into account the limited economic and technical capabilities of many owners and operators of solid waste disposal facilities.

In carrying out this mandate, EPA has undertaken efforts to revise the current Criteria. EPA is initially limiting the Criteria revisions to municipal solid waste landfills (MSWLFs) because these are the facilities for which the Agency has the most complete and reliable data as discussed in the Revised Final Draft Report to Congress: Solid Waste Disposal in the United States, Volume I and II [EPA, 1988]. The rationale for limiting the criteria revisions to MSWLFs is further discussed in the Background Document for Options Selection [EPA, 1986e].

The purpose of this report is to present information on the character of leachate from MSWLFs based on a study of existing leachate data. Section 2.0 briefly discusses the objectives of this report, Section 3.0 describes the sources of the data and its quality, and Section 4.0 presents the results of the study.

2.0 OBJECTIVE

The purpose of this study was to investigate MSWLF leachate: to determine some of the constituents* present, the concentrations of the constituents present relative to human health and environmental regulatory standards, and the effect of Subtitle C hazardous waste regulations on constituent concentrations in MSWLF leachate. To accomplish this purpose, the following four objectives were set:

(1) Identify constituents and determine their concentrations in MSWLF leachate.

(2) Compare concentrations of constituents in leachate from MSWLFs which began operation prior to the 1980 promulgation of the Subtitle C waste regulations, to leachate from landfills that began operation after 1980. In this report, landfills which began operation prior to or during 1980 are referred to as "pre-1980" landfills. Those that began operation after 1980 are referred to as "post-1980" landfills.

(3) Compare concentrations of constituents in MSWLF leachate to concentrations in leachate from hazardous waste landfills.

(4) Compare concentrations of constituents in MSWLF leachate to human health and environmental based regulatory standards, as some basis for drawing conclusions about the potential threat of MSWLF leachate to human health and the environment.

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* Constituents, as used in this report, are the parameters reported in a chemical analysis of a leachate sample. In this report constituents are subdivided into inorganics and organics, with inorganics including indicator parameters such as pH and conductivity.

3.0 DESCRIPTION OF DATA

3.1 Data Sources

Six independent studies were used to provide data on MSWLF leachate. These studies provided leachate data for 83 MSWLFs; 60 landfills provided both organic and inorganic leachate analyses, 16 landfills provided only inorganic analyses, and seven landfills provided only organic analyses. A seventh study provided information on leachate from 11 hazardous waste landfills. Each of these seven studies are described below. The data are presented in Appendix A. Summary data on the number of sites, samples, and constituents are provided in Table 3-1.

3.1.1 Wisconsin Study

The Wisconsin study provided organic and inorganic chemical analyses of leachate at 20 landfills [McGinley, 1984]. The study provided data on waste types and either exact ages or minimum ages of all landfills.

All 20 landfills were sampled and analyzed for inorganics; in most cases more than once; sometimes up to 300 times. Collectively, samples were analyzed for 54 different inorganic constituents; however, not all samples were analyzed for the same constituents. The results of the inorganic analyses were composited. Eighteen sampling locations at nine landfills were analyzed for 114 organics. The study provided median concentrations of all analyses for each constituent at a given sample location.

3.1.2 NUS Study

The NUS study provided analyses of 19 leachate samples from six municipal landfills. Two (2) of the landfills are co-disposal landfills, disposing of municipal waste with municipal incinerator ash [EPA, 1987]. Additional information on the other four landfills was provided in case studies performed for EPA [EPA, 1986a, 1986b, 1986c, 1986d].

TABLE 3-1

SUMMARY OF DATA USED, BY SOURCE

Landfill Study	Number of Sites	Inorganics		Organics		Total	
		Number of Samples	Number of Constituents Analyzed For*	Number of Samples	Number of Constituents Analyzed For	Number of Samples	Number of Constituents Analyzed For
Municipal							
Wisconsin	20	20 composites	54	24	114	44	168
NUS	6	15	46	19	210	19	256
Trade Assoc.	6	0	0	6	48	6	48
Sobotka	27	27	46	22	48	27	94
Texas A&M	1	0	0	1	24	1	24
WMI	23	104	50	104	204	104	254
Subtotal	83	166	--	176	--	201	--
Hazardous Waste							
TRW	11	27	46	23	32	34	94
TOTAL	94	193	--	199	--	235	--

* Includes some constituents detected less than twice

Each sample was analyzed for all substances listed in proposed Appendix IX of 40 CFR Part 261, including 210 organics (volatile, semivolatile, pesticide, herbicide, and PCB) and 46 inorganics. The inorganics included 18 water quality indicators. Concentrations of constituents detected were reported for 46 inorganic constituents and 19 organic constituents; detection limits were not reported.

3.1.3 Trade Association Case Studies

The Trade Association Case studies provided organics analyses of leachate from case studies performed at six MSWLFs [EPA, 1988]. Data was provided for each of the landfills, with a single analysis per landfill. It is not known whether a single sample was collected per analysis or whether several samples were composited [EPA, 1988]. For this report, the results were assumed to represent a single sample. Although all constituents analyzed for is unknown, 48 constituents were identified.

3.1.4 Sobotka Study

The Sobotka study gathered organic and inorganic analyses of leachate from 44 MSWLFs in 10 states [EPA, 1986f]. Seventeen (17) of those landfills were addressed under the Wisconsin Study; therefore, the Sobotka study provided additional information on 27 studies. The study provided one sample analysis (possibly a composite) for each site; the results were treated, in this report, as a single (uncomposited) sample. The study listed 46 inorganic and 48 organic constituents for which analyses were conducted.

3.1.5 Texas A&M Study

The Texas A&M study provided organics analysis of leachate at three MSWLFs [EPA, 1986f]. Two landfills were included in the Sobotka Study; therefore, this study provided additional data on only one landfill. The study provided one sample analysis with 24 constituents for this landfill [EPA, 1986f]. For this report it was assumed the sample was not composited, although this was not verified. The number of samples and the complete list of constituents analyzed for was not provided.

3.1.6 Waste Management Incorporated Study

Waste Management Incorporated (WMI) provided EPA with organic and inorganic analyses data for leachate collected at 23 WMI MSWLFs [Baker, 1987]. The data included analyses for 50 inorganic and 204 organic constituents. A total of 104 samples were analyzed although not all samples were analyzed for all constituents. WMI also provided waste types disposed at the landfills.

3.1.7 TRW Study

The TRW study provided leachate data for 11 hazardous waste landfills [EPA, 1983]. Nine of the landfills were analyzed for both inorganic and organic constituents; one was analyzed only for inorganics; and one only for organics. Twenty-seven (27) samples from ten landfills were analyzed for 46 inorganic constituents, and 23 samples from ten landfills (nine of the previous ten plus one additional landfill) were analyzed for 32 organic constituents. Information in the text occasionally differed from that provided in the appendices, making it difficult to always determine the correct value.

3.2 Data Base

Data from the above sources were compiled in a computerized data base. Concentrations of leachate were entered in four categories - three based on the age of the MSWLF (pre-1980, post-1980 and undated) and one from hazardous waste landfills. These four categories were subdivided into organics and inorganics; physical parameters (e.g., TDS, pH) were grouped with the inorganics. The number of landfill sites, samples collected, and constituents analyzed for each category are presented in Table 3-2.

The number of inorganic and organic constituents common to groups of landfill categories are presented in Table 3-3. (The standards referred to are discussed in Section 4.)

TABLE 3-2

DESCRIPTION OF DATA BASE

Landfill Categories	Inorganics			Organics		
	Number of Sites	Number of Samples	Number of Constituents Analyzed For	Number of Sites	Number of Samples	Number of Constituents Analyzed For
Municipal						
Pre-1980	36	107	64	25	107	62
Post-1980	6	23	52	9	30	54
Undated	34	36	54	33	39	62
Subtotal	76	166	--	67	176	--
Hazardous Waste	10	27	46	10	23	32
TOTAL	86	193	--	77	199	--

TABLE 3-3

CONSTITUENTS COMMON TO LANDFILL CATEGORIES

Landfill Categories	Number of Inorganic Constituents Detected			Number of Organic Constituents Detected
	Indicator Parameters	Other Inorganics	Total	
Pre-1980/Post-1980	24	14	38	13
Post-1980/Hazardous Waste	17	14	31	9
Pre/Post/Hazardous Waste	15	14	29	8
Pre-1980/Standards	4	16	20	42
Post-1980/Standards	4	16	20	27
Hazardous Waste/Standards	3	16	19	25
Pre/Post/Hazardous/Standards	2	11	13	5

3.3 Data Quality

The quality of the data determines the validity of any deductions. The weaknesses of the data used in this study should be kept in mind when interpreting the results. Some of these weaknesses are listed in Table 3-4. The weaknesses are generally those of sample size and sample representativeness; consistency in and quality of methods of sampling and analysis, and in reporting; and completeness of information provided.

The sample size is limited. Leachate data was collected for approximately one percent of the approximately 6,000 landfills currently operating in the United States. The sample representativeness is also questionable because the leachate data were not selected randomly, but based on availability. For example, the Wisconsin study investigated landfills only within that state. In addition, leachate constituents used for comparison were those most commonly analyzed for.

Second, sampling methods and analytical protocol differed or were not reported, making it difficult to determine the comparability of the data. For instance, the detection level for a given constituent may have been reported as 5 in one study, 20 in another, and simply as "not detected" in a third. The constituent may actually have been present in two of the three studies at a level above the lowest detection level (in this example, 5). However, this cannot be determined from the data provided.

Third, the data is incomplete. Leachate data for a site seldom included such information as landfill age, type of wastes disposed, or analytical procedures used.

TABLE 3-4

FACTORS AFFECTING DATA QUALITY

Factor	Discussion
Sample Size	The number of landfills represented in this study may not constitute a large enough sample size to come to firm statistical conclusions.
Sample Representativeness	It is unknown how representative the samples of MSWLF leachate collected are of the landfill and of the time the sample was collected.
Landfill Age	Leachate is considerably more concentrated during the early stages of landfill decomposition. The sources are generally not detailed enough to estimate landfill age at time of sampling .
Leachate Collection System	Leachate collection systems can vary from sophisticated to crude. Most systems have a tendency to lose the volatile component of leachates over time and also allow chemical oxidation to occur. This can affect the concentration of both inorganic and organic components.
Sampling and Analytical Conditions	Data quality depends on sampling and analytical methods and equipment. Most sources did not contain enough detailed information to determine whether appropriate equipment and methods were used. Detection limits differed or were not reported.
Target Compounds	For some sources it was not possible to determine whether compounds were undetected or simply not analyzed for.
QA/QC Requirements	Some sources did not provide detailed enough QA/QC requirements or results of QA/QC check samples (e.g., blanks, analytical controls).
Engineering Controls	Engineering controls on landfills (i.e., landfill covers, run-on/run-off controls) can drastically affect leachate composition. Most sources did not report the presence or conditions of engineering controls.
Waste Composition	Waste composition controls leachate composition. History of wastes accepted was not available for many landfills.

4.0 DISCUSSION

The data were evaluated to (1) characterize MSWLF leachate; (2) determine any differences between pre- and post-1980 MSWLF leachate; (3) determine differences between post-1980 MSWLF leachate and hazardous waste landfill leachate; and (4) compare the MSWLF leachate to human health and environmental based standards. The results are presented below.

All constituents analyzed for in the leachate samples were used to characterize the MSWLF leachate. Most of the constituents detected less than two times were omitted from the comparisons to eliminate the constituents least likely to be representative of the leachate. The omitted constituents are listed in Appendix B, Table B-1.

4.1 Characterization of MSWLF Leachate Constituents

MSWLF leachate was characterized by determining the number of constituents detected in different constituent categories. Summary information on the constituents found in MSWLF leachate is provided in Table 4-1. Information on the specific constituents is provided in Appendix B.

Approach - Leachate constituents were broken into two main categories: inorganics and organics. Inorganics were broken into two subcategories: indicator parameters (e.g., temperature, pH) and other inorganics (generally metals). Four subcategories of organics were used: (1) pesticides, herbicides, and PCBs; (2) volatile organics; (3) semivolatile organics; and (4) other organics. Table 4-1 provides, for each constituent category, the number of constituents analyzed for, the number of constituents detected, the number of constituents not detected, the total number of detections (i.e., the sum of all detections for all constituents), and the average number of detections per constituent.

More complete information on the constituents is provided in Appendix B, Tables B-2 through B-8. Minimum, maximum, median and average leachate concentrations, standard deviations, and number of time constituents were analyzed for are provided in Table B-2 through B-4 for MSWLFs (pre-1980, post-1980 and undated landfills, combined). Tables B-5 through B-8 provide minimum,

TABLE 4-1

DESCRIPTION OF CONSTITUENTS* OF MSWLF LEACHATE

Constituent Category	Number of Constituents Analyzed For	Constituents Detected		Constituents Never Detected		Total Number of Detections	Average Number of Detections per Constituent
		Number	Percent	Number	Percent		
Inorganics							
Indicator parameters	33	33	100	0	0	1,140	36
Other inorganics	25	22	88	3	12	998	40
Subtotal	58	55	95	3	5	2,138	37
Organics							
Pesticides, herbicides, PCBs	41	6	15	35	85	29	1
Volatiles	47	36	77	11	23	528	11
Semivolatiles	93	22	24	71	76	173	2
Others	94	24	24	70	76	312	3
Subtotal	275	89	32	187	68	1,042	4
TOTAL	333	143	43	190	57	3,180	10

* All constituents analyzed for (includes Appendix B, Table B-1 constituents).

maximum, and median leachate concentrations, and the number of sites at which constituents were detected, for pre-1980 and post-1980 MSWLFs and for hazardous waste landfills.

Results - Three hundred and thirty-three (333) constituents analyzed for were detected 3,180 times, for an average of ten detections per constituent. Inorganics were more frequently detected than organics. One hundred and ninety (190) constituents were analyzed for but not detected: three inorganics (5 percent) and 187 organics (68 percent). Table 4-1 summarizes these results. Tables B-2 through B-4 in Appendix B show that the standard deviations of the constituents are of the same order of magnitude as the average and median values.

4.2 Comparison of Pre-1980 to Post-1980 MSWLF Leachate

Pre-1980 and post-1980 MSWLF leachates were compared by studying both the frequency of which types of constituents were detected and the ratios of the median concentrations of the constituents.

4.2.1 Frequency of Detection

Approach - Pre- and post-1980 MSWLF leachates were compared by determining the frequency which constituents were detected in the leachate. Table 4-2a provides the number of constituents detected based on their frequency of detection. The information is provided for both inorganics and organics.

Table 4-2b presents the ratio of the number of times inorganic and organic constituents were not detected versus the number of times they were detected as a basis for comparing pre- and post-1980 leachate. These ratios are provided in Appendix C, Tables C-1 and C-2 for individual constituents.

Results - Table 4-2a shows that over half the inorganic constituents (61 percent in pre-1980 leachate and 68 percent post-1980 leachate) were detected more than 81 percent of the time. The table also shows that over half the organic constituents (63 percent pre-1980 and 79 percent post-1980) were detected less than 20 percent of the time.

TABLE 4-2

COMPARISON OF DETECTION FREQUENCIES IN PRE- AND POST-1980 MSWLF LEACHATE

Frequency of Detection	a. Number of Constituents by Detection Frequency					
	Pre-1980			Post-1980		
	Inorganics**	Organics	Total	Inorganics**	Organics	Total
Very low (0-20%)	0	37	37	7	42	49
Low (21-40%)	6	6	12	1	2	3
Moderate (41-60%)	4	8	12	1	3	4
High (61-80%)	4	3	7	2	4	6
Very High (81-100%)	30	5	35	30	2	32
Totals	44	59	103	41	53	94

	b. Ratio of Constituents Detected to Those Not Detected					
	Pre-1980			Post-1980		
	Inorganics**	Organics	Total	Inorganics**	Organics	Total
Total Constituents Not Detected	163	1,761	1,924	50	475	525
Total Constituents Detected	1,379	497	1,876	286	72	358
Total	1,542	2,258	3,800	336	547	883
Ratio of Constituents Not Detected to Constituents Detected	0.1	3.5	1.0	0.2	6.6	1.4

** Does not include pH, eH or temperature as these parameters are always "detectable"

The ratios of constituents not detected to those detected are shown below:

MSWLF leachate	Inorganics	Organics	Total
pre-1980	0.1	3.5	1.0
post-1980	0.2	6.6	1.4

4.2.2 Ratio of Median Concentrations

Approach - Median values of pre-1980 MSWLF leachate were compared to post-1980 values by creating ratios of the pre to post values for each constituent for which both common values existed (35 inorganic constituents and 13 organic constituents; see Table 3-3). pH, eH and temperature were omitted as inappropriate. Only constituents with values above the detection limits were used.

The ratios were grouped by powers of ten, and the results presented on a bar graph (Figure 4-1). The incremental range around the ratio one is from log ratio -0.5 to 0.5 (1:3.15 to 3.15:1 in non-log terms). The height of the bar represents the number of occurrences of a given ratio. The ratios of the individual constituents and the tabulated values are provided in Appendix C, Tables C-3 and C-4.

Minimum and maximum concentrations of pre- and post-1980 constituents were also analyzed. These results are provided in Appendix C (Figure C-1 and Tables C-5 and C-6 for the minimum concentrations; Figure C-2 and Tables C-7 and C-8 for the maximum concentrations).

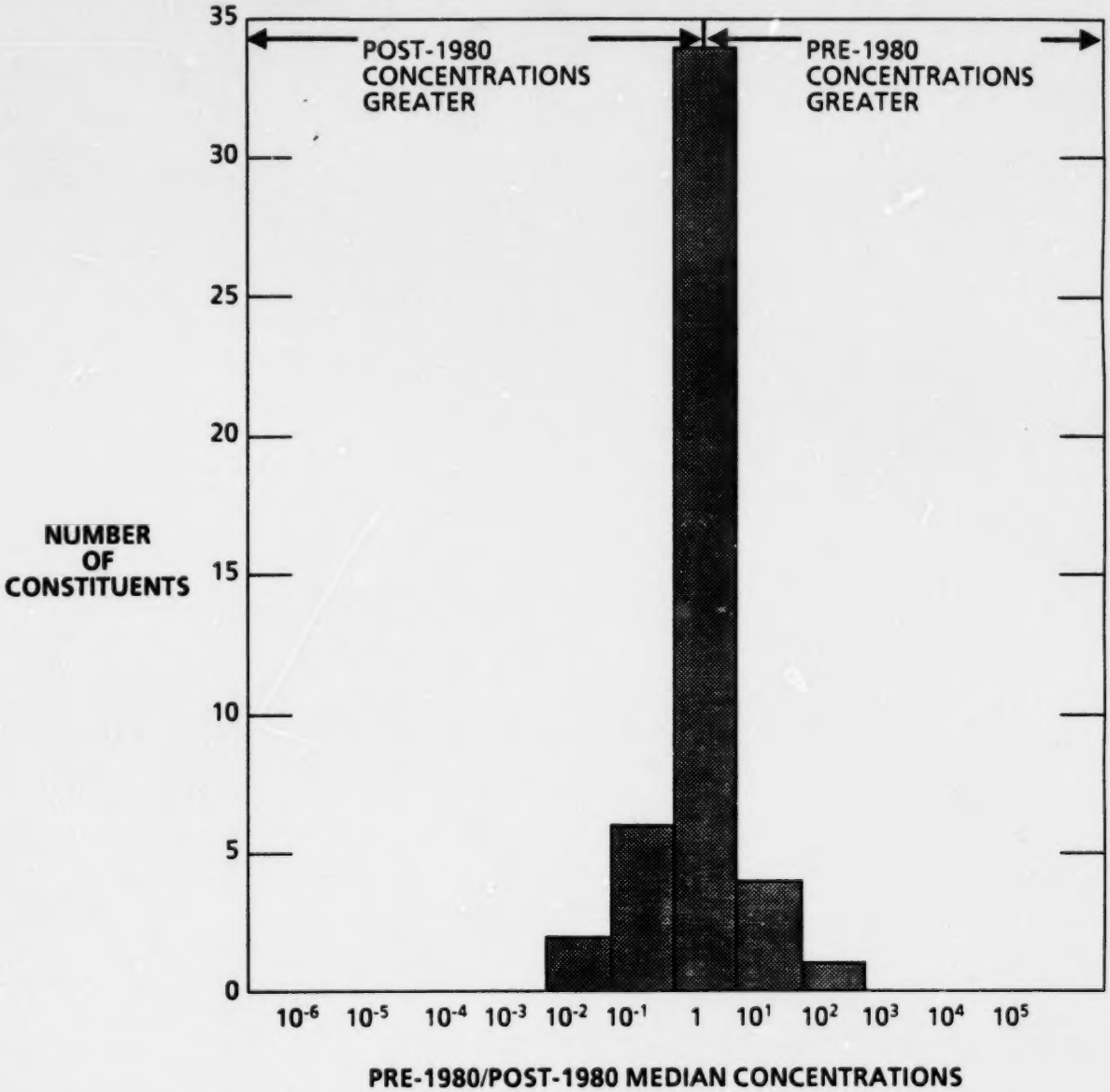
Results - As can be seen from Figure 4-1, approximately three-quarters of the constituents found center around one, within the increment from 1/3.15 to 3.15/1. Distributions of minimum and maximum values are similar. This result indicates little evidence of a difference based on starting date.

4.3 Comparison of MSWLF Leachate to Hazardous Waste Landfill Leachate

MSWLF leachate was compared to hazardous waste landfill leachate by studying ratios of their median concentrations.

FIGURE 4-1

PRE-1980 VS POST-1980 MEDIAN MSWLF LEACHATE CONCENTRATIONS



Approach - Post-1980 MSWLF leachate was compared to hazardous waste landfill leachate by comparing median concentrations of their 40 common constituents (31 inorganics and 9 organics) by creating ratios of the concentrations of each of the constituents. These ratios were plotted on a bar graph (Figure 4-2) following the procedure described above for Figure 4-1. The ratios of the individual constituents and the tabulated values used in Figure 4-2 are provided in Appendix C, Tables C-9 and C-10.

Results - About half the ratios of post-1980 MSWLF versus hazardous waste landfill leachate are near (between 1/3.15 and 3.15/1) the value of one. The number above this increment is approximately twice that below the increment, a weak indication that the hazardous waste leachate had higher concentrations of hazardous constituents than the post-1980 MSWLF leachate. The result cannot be considered strongly significant as the sample size is small.

4.4 Comparison of MSWLF Leachate to Standards

MSWLF leachate concentrations (for pre-1980, post-1980 and undated landfills combined) were compared to regulatory standards in three ways: plotted ratios; tabulated ratios; and number of sites exceeding standards. One of three allowable exposure standards was used as the standard. The National Interim Primary and Secondary Drinking Water Standards (MCLs) were used, if available. If not available, the EPA-established human health-based criteria for systemic toxicants and carcinogens were used. The Federal Water Quality Criteria were used if neither of the other two standards were available. If none of these standards existed, a comparison was not made. The standards are shown in Appendix C, Table C-13.

4.4.1 Plotted Ratios

Approach - Median MSWLF concentrations were compared to the standards by creating ratios of the median concentration of each of the constituents to the standard and plotting these ratios on a bar graph (Figure 4-3) following the procedures used to create Figures 4-1 and 4-2. Sixty-two ratios were created from the 62 constituents for which standards were available. The ratios of the individual constituents and the tabulated values used in Figure 4-3 are provided in Appendix C, Tables C-11 and C-12.

FIGURE 4-2

HAZARDOUS WASTE LANDFILL VS MEDIAN POST-1980 MSWLF LEACHATE CONCENTRATIONS

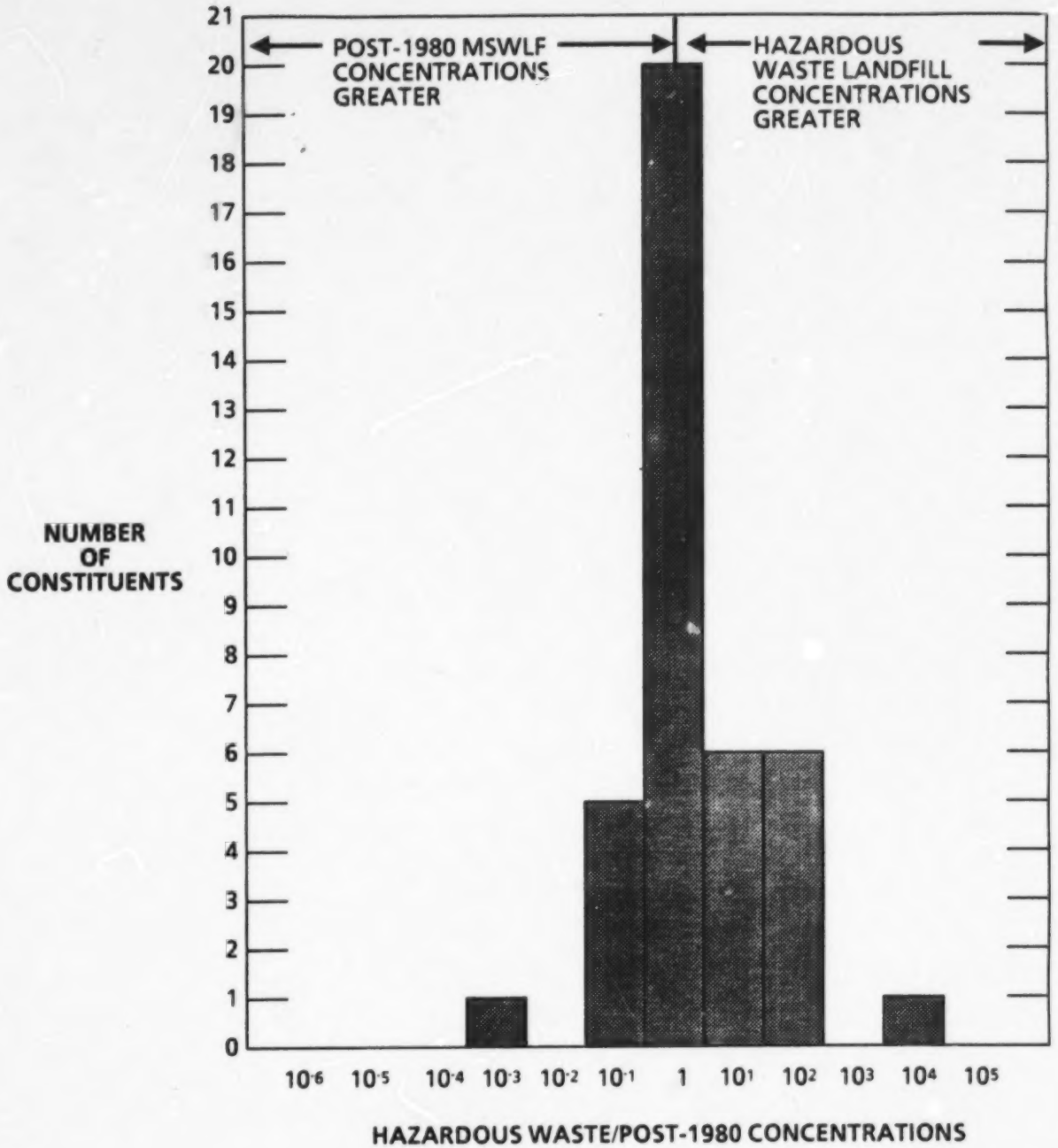
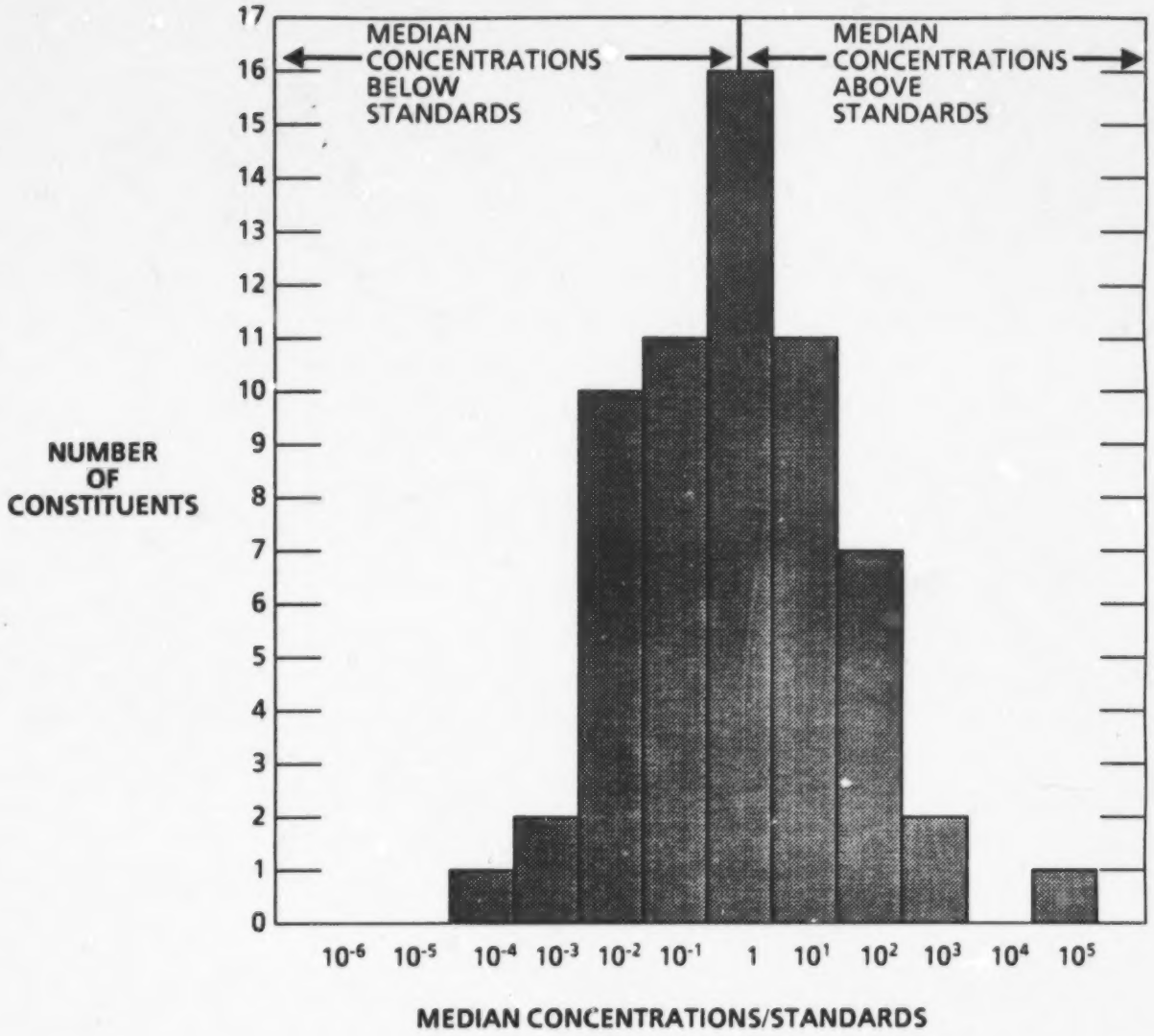


FIGURE 4-3

MEDIAN MSWLF* LEACHATE CONCENTRATIONS VS STANDARDS



* Includes pre-1980, post-1980 and undated landfills

Average concentrations were compared in the same way. These results are provided in Appendix C, Figure C-3 .

Results - As can be seen from Figure 4-3, over half the constituents were found near or greater than a concentration ratio of one, within the range of 1:31.5 to 31.5:1. Similar results are shown for the average concentrations (Appendix C, Figure C-3).

4.4.2 Tabulated Ratios

Approach - The average concentration of each constituent was compared to its regulatory standard by creating a ratio of concentration to standard. These ratios were grouped by powers of ten because the results were logarithmically distributed. The results are shown in Table 4-3. The fractions shown in Table 4-3 are

TABLE 4-3

COMPARISON OF AVERAGE MSWLF CONCENTRATIONS TO STANDARDS

Ratio of Median Concentrations to Standards	Inorganics		Organics		Total	
	Fraction	Percent	Fraction	Percent	Fraction	Percent
Less than 1	8/19	42	18/43	42	26/62	42
1-10	6/19	32	8/43	19	14/62	23
10-100	2/19	11	13/43	30	15/62	24
Greater than 100	3/19	16	4/43	9	7/62	11

the fraction of constituents with ratios within the specified range. The numerators and denominators are the actual number of constituents. The percents in Table 4-3 correspond to the fractions. The ratios of the individual constituents are provided in Appendix C, Table C-13.

Results - Of the 62 constituents with standards, 26 constituents (42 percent) had a ratio of less than 1; i.e., the average concentration was less than the standard. Fourteen constituents (23 percent) had a ratio greater than one and less than ten; 15 constituents' ratios (24 percent) fell between 10 and 100. Seven constituents (11

percent) had median concentrations more than 100 times that of the standard. One, bis (chloromethyl) ether, was over 10,000 greater than the standard.

4.4.3 Number of Sites Exceeding Standards

Approach - For each site, the number of times the concentration of a constituent exceeded a standard and exceeded 1,000 times the standard were counted. The value 1000 times the standard was arbitrarily selected to represent attentuation of the leachate constituents prior to human exposure. The tabulated results were put in one of four groups by number of standards exceeded: zero; only one; two to four; and five or more. Sites were grouped according to pre-1980, post-1980 and undated MSWLFs and hazardous waste landfills. The results are shown in Table 4-4, both as fractions and as percents. The denominator of the fractions represent the number of sites in the given landfill category. In Table 4-4a, the numerators are the number of sites (by landfill category) with the indicated number of constituents with concentrations exceeding the standards; in Table 4-4b, the numbers are the number of sites with the indicated number of constituents exceeding 1000 times the standards. The percents are the percent of sites (by landfill category) with the indicated number of constituents exceeding standards (4-4a) or 1000 times the standards (4-4b). Table 4-4c provides basic information about the sample size. Tables C-14 through C-17 in Appendix C provide the breakdown by site.

Results - Pre-1980 MSWLF sites exceeded five or more standards somewhat more frequently than either the hazardous waste landfill sites or the post-1980 sites. Both pre- and post-1980 MSWLF sites were more likely not to exceed 1,000 times any standard than were hazardous waste landfill sites.

TABLE 4-4

NUMBER OF SITES EXCEEDING STANDARDS

Number of Standards Exceeded	a. Sites with Constituents Exceeding Standards									
	Fraction[1]					Percent[2]				
	MSWLFs				Haz Waste Landfills	MSWLFs				Haz Waste Landfills
	Pre-1980[3]	Post-1980	Un-dated	Total		Pre-1980[3]	Post-1980	Un-dated	Average	
0	0/26	0/8	2/37	2/71	1/10	0	0	5	3	10
1	2/26	2/8	8/37	12/71	2/10	8	25	21	17	20
2-4	8/26	3/8	10/37	21/71	2/10	31	38	27	30	20
5 or more	16/26	3/8	17/37	36/71	5/10	62	38	46	51	50

Number of Standards Exceeded	b. Sites with Constituents Exceeding 1000 x Standards									
	Fraction[1]					Percent[2]				
	MSWLFs				Haz Waste Landfills	MSWLFs				Haz Waste Landfills
	Pre-1980[3]	Post-1980	Un-dated	Total		Pre-1980[3]	Post-1980	Un-dated	Average	
0	21/26	7/8	34/37	60/71	5/10	81	88	92	85	50
1	3/26	1/8	2/37	6/71	4/10	12	13	5	9	40
2-4	2/26	0/8	1/37	3/71	1/10	8	0	3	4	10
5 or more	0/26	0/8	0/37	0/71	0/10	0	0	0	0	0

	c. Number of Sites and Constituents per Site				
	MSWLFs				Hazardous Waste Landfills
	Pre-1980	Post-1980	Undated	Total	
Number of Sites	26	8	37	71	10
Average Constituents per Site	34	28	14	23	13

1 Denominators are number of sites in landfill category; numerators are number of sites in that category exceeding indicated number of standards

2 May not sum to 100 due to rounding

3 Wisconsin sites with only composite samples are not included

5.0 REFERENCES

Baker, John A. Personnel communication from J. Baker (WMI) to S. Mooney (EPA); concerning Leachate data; December 1, 1987.

McGinley, Paul M., and Peter Kmet; Formation, Characteristics, Treatment and Disposal of Leachate from Municipal Solid Waste Landfills; Wisconsin Department of Natural Resources; 1984.

U.S. Environmental Protection Agency; Compilation of Hazardous Waste Leachate Data; Office of Solid Wastes; Washington, D.C.; prepared by TRW; 1983.

U.S. Environmental Protection Agency; Case Study, Short Mountain Sanitary Landfill, Goshen, Oregon, Draft Report; Office of Solid Waste; Washington, D.C.; unpublished; prepared by ICF Northwest; 1986a.

U.S. Environmental Protection Agency; Case Study, Van-Dal Landfill, Durango, Colorado, Final Report; Office of Solid Waste; Washington, D.C.; unpublished; prepared by PEI Associates, Incorporated; 1986b.

U.S. Environmental Protection Agency; Case Study, Portage County Landfill, Stevens Point, Wisconsin, Draft Report; Office of Solid Waste; Washington, D.C.; unpublished; prepared by ICF Northwest; 1986c.

U.S. Environmental Protection Agency; Case Study, Franklin County Sanitary Landfill, Greenpoint, Florida; Office of Solid Waste; Washington, D.C.; unpublished; prepared by SRW Associates, Incorporated; 1986d.

U.S. Environmental Protection Agency; Background Document for Options Selection; 1986e.

U.S. Environmental Protection Agency; Determination of Municipal Landfill Leachate Characteristics, Leachate Baseline Report; Office of Solid Waste; Washington, D.C.; unpublished; prepared by NUS Corporation, 1986f.

U.S. Environmental Protection Agency; Characterization of Leachates from Municipal Waste Disposal Sites and Codisposal Sites, Volume 6; Office of Solid Waste; Washington, D.C.; prepared by NUS Corporation, 1987.

U.S. Environmental Protection Agency; Report to Congress: Solid Waste Disposal in the United States, Volume I and II, Revised Final Draft, Office of Solid Waste; Washington, D.C.; unpublished, April 1988.

APPENDIX A

DATA USED IN THIS REPORT

NOTES

1. Concentrations of all inorganic constituents in parts per million unless noted otherwise; concentrations of organic constituents in parts per billion.

2. Negative values denote reported detection limit when substance was not detected.

3. ND = Substance was analyzed for and not detected.

4. *** NA *** = Substance was not analyzed for.

5. >> UNK << = No data were reported from source; substance was either not detected or not analyzed for.

6. Source identification is as follows:

Sobotka - Sobotka & Co., Incorporated; Case history data compiled and reported in a July 1986 report to the U.S. EPA's Economic Analysis Branch of the Office of Solid Waste; Washington, D.C.; 1984.

NUS - U.S. Environmental Protection Agency; Determination of Municipal Landfill Leachate Characteristics, Leachate Baseline Report; prepared by NUS Corporation; 1986.

Texas - Brown, K.W., and K.C. Donnelly; The Occurrence and Concentration of Organic Chemicals in Hazardous and Municipal Waste Landfill Leachate; Texas A&M University, Soil and Crop Sciences Department, College Station, Texas; undated.